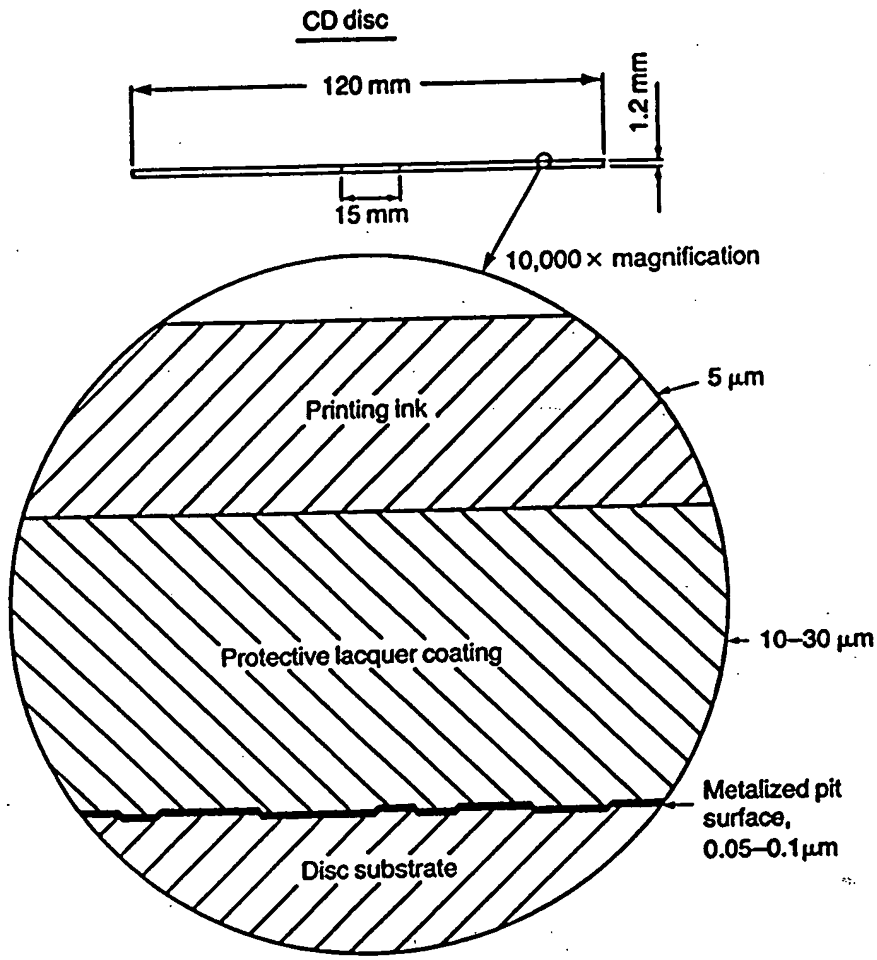
104706-111

DISC	
Playing time:	74 minutes, 33 seconds maximum
Rotation:	Counter-clockwise when viewed from readout surface
Rotational speed:	1.2–1.4 m/sec.
Track pitch:	1.6 μm
Diameter:	120 mm
Thickness:	1.2 mm
Center hole diameter:	15 mm
Recording area:	46 mm–117 mm
Signal area:	50 mm–116 mm
Material:	Any transparent material with 1.55 refraction index, such as polycarbonate
Minimum pit length:	0.833 μm (1.2 m/sec.) to 0.972 μm (1.4 m/sec.)
Maximum pit length:	3.05 μm (1.2 m/sec.) to 3.56 μm (1.4 m/sec.)
Pit depth:	Approx. 0.11 μm
Pit width:	Approx. 0.5 μm
OPTICAL SYSTEM	
Standard wavelength:	$\lambda = 780$ nm (7,800Å)
Focal depth:	± 2 μm
($\lambda/NA \leqq 1.75$ μm, NA: Numerical Aperture)	
SIGNAL FORMAT	
Number of channels:	2 channels (4-channel recording possible)
Quantization:	16-bit linear quantization
Quantizing timing:	Concurrent for all channels
Sampling frequency:	44.1 kHz
Channel bit rate:	4.3218 Mb/sec.
Data bit rate:	2.0338 Mb/sec.
Data-to-channel bit ratio:	8:17
Error correction code:	CIRC (with 25% redundancy)
Modulation system:	EFM

Table 3.1 *Specification table for the compact disc system.*

Prior Art Figure 1



Prior Art Figure 2

Figure 3.1 *Scale drawing of CD data surface.*

thickness is 1.2 millimeters. The innermost part of the disc does not hold data; it provides a clamping area for the player to hold the disc firmly to the spindle motor shaft. Data is recorded on an area 35.5 millimeters wide. A lead-in area rings the innermost data area, and a lead-out area rings the outermost area. The lead-in and lead-out areas contain non-audio data used to control the player. On many discs, a change in appearance in the reflective data surface marks the end of the musical information.

A transparent plastic substrate forms most of a disc's 1.2 millimeter thickness. Data is physically contained in pits which are impressed along its top surface and are covered with a very thin (50 to 100 nanometers) metal (e.g., aluminum, silver, or gold) layer. Another thin (10 to 30 micrometers) plastic layer protects the metalized pit surface, on top of which the

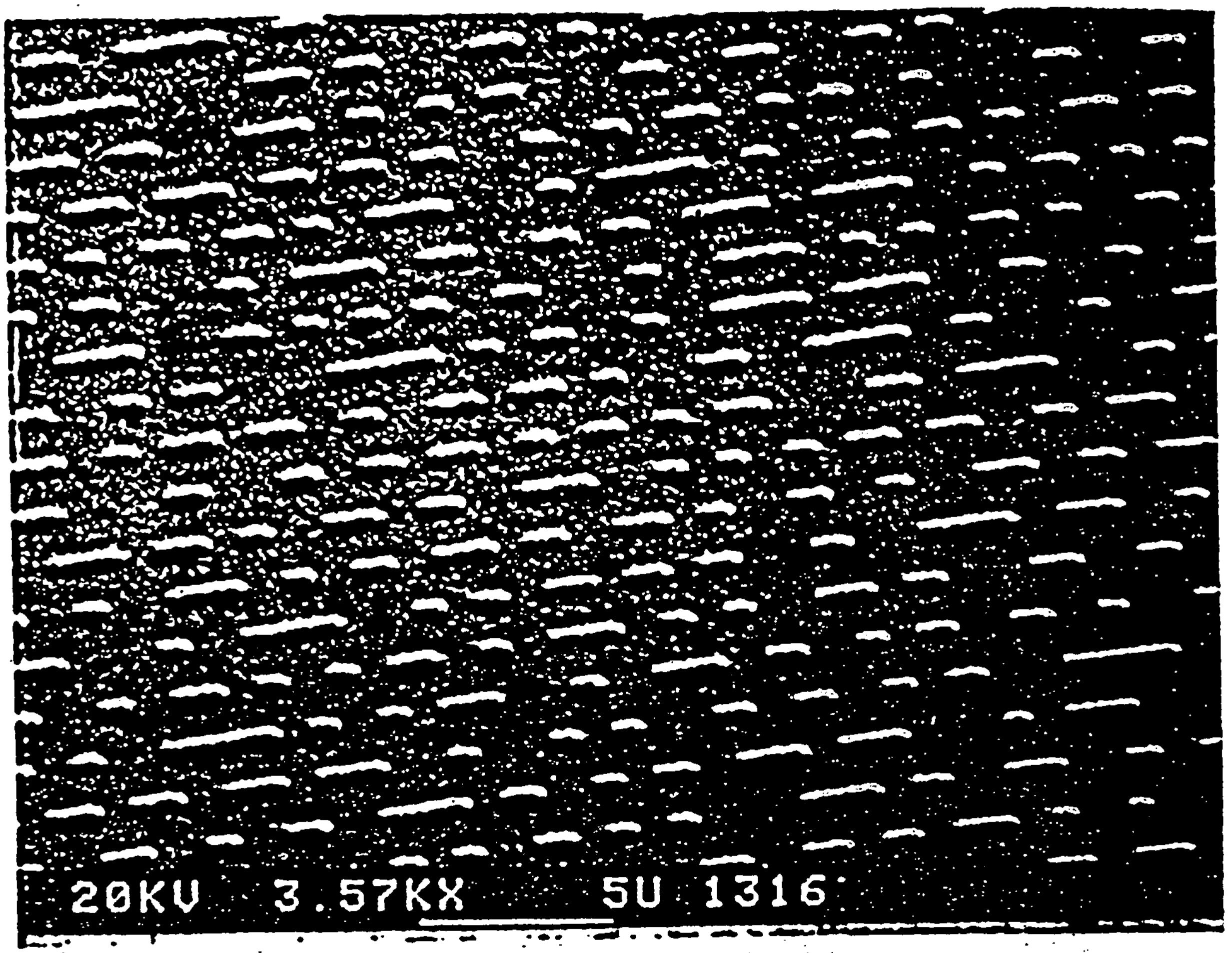


Figure 3.2 ***Compact disc pit surface (photo: University of Miami).***

Prior Art Fig. 3

with shorter playing time thus provide a greater manufacturing yield. In addition, by starting from the inside, adoption of smaller diameter discs (such as 8 centimeter CD-3 discs) or larger diameter discs (such as 20 and 30 centimeter CD-Video discs) is facilitated.

Figure 3.3 diagrams the track pitch, the distance between successive tracks, which is 1.6 micrometers (that's about 600 tracks to a millimeter). There are 22,188 revolutions across the disc's signal surface of 35.5 millimeters. A pit track might contain 3 billion pits. Unspiraled, the track would stretch about 3½ miles. The construction of the CD is diffraction-limited—that is, the wave nature of light would not permit smaller formations. The track pitch acts as a diffraction grating, producing a rainbow of colors. In fact, CD pits are among the smallest of all manufactured formations.

Examination of a pit track would reveal that the linear dimensions of the track are the same at the beginning of its spiral as at the end. This means that a CD must rotate with CLV (constant linear velocity), a condition in which a uniform relative velocity is maintained between the disc and the pickup.

Prior Art
Fig. 4

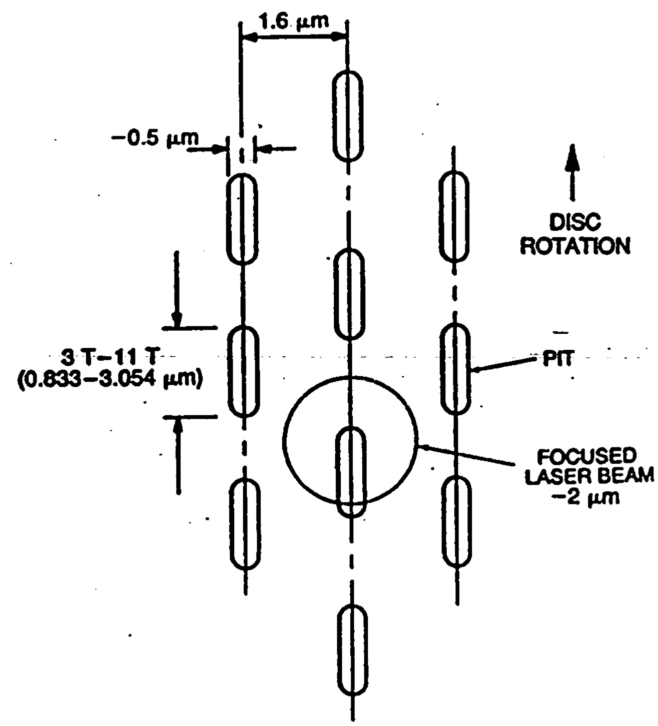


Figure 3.3 *Track pitch is 1.6 micrometers. Data is read through an intensity-modulated laser beam.*

ters. The height of the bumps is thus approximately 1/4 of the laser's wavelength in the substrate.

Assume the height is exactly 1/4 the laser's wavelength. Light striking land thus travels a distance 1/2 wavelength (1/4 + 1/4) further than light striking a bump. This creates a phase difference of 1/2 wavelength between the part of the beam reflected from the bump and the part reflected from the surrounding land, as shown in figure 3.5. The phase difference causes the two parts of the beam to destructively interfere with and cancel each other, forming a diffraction pattern. In short, a bump disperses light, reducing the intensity of the reflected light.

In theory, when the beam strikes an area between pits, virtually all of its light is reflected, and when it strikes a pit, virtually all of its light is cancelled, so that virtually none is reflected. In practice, the laser spot is larger than is required for complete cancellation between pit and land reflections, and pits are made slightly shallower than the theoretical figure of 1/4 wavelength; this yields a better tracking signal, among other things. About 25 percent of the power of the incident light is reflected from a long bump. In any case, the presence of pits and land is thus read by the laser beam; specifically, the disc surface modulates the intensity of the light beam. Thus the data physically encoded on the disc can be recovered by the laser and later converted to an electrical signal.

So much for the physically obvious, whether visible to the naked eye or not. Not obvious at all is the format by which the data is physically encoded

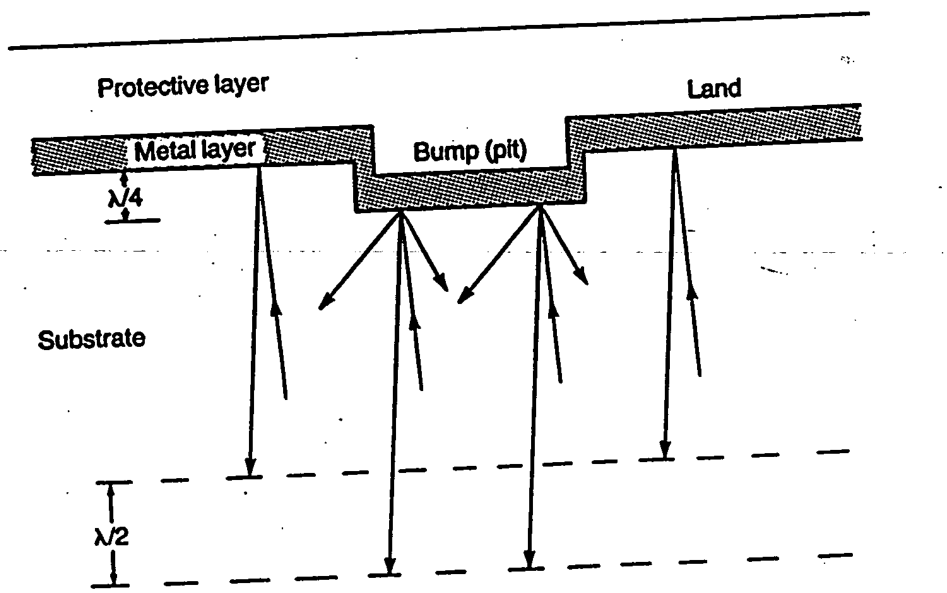
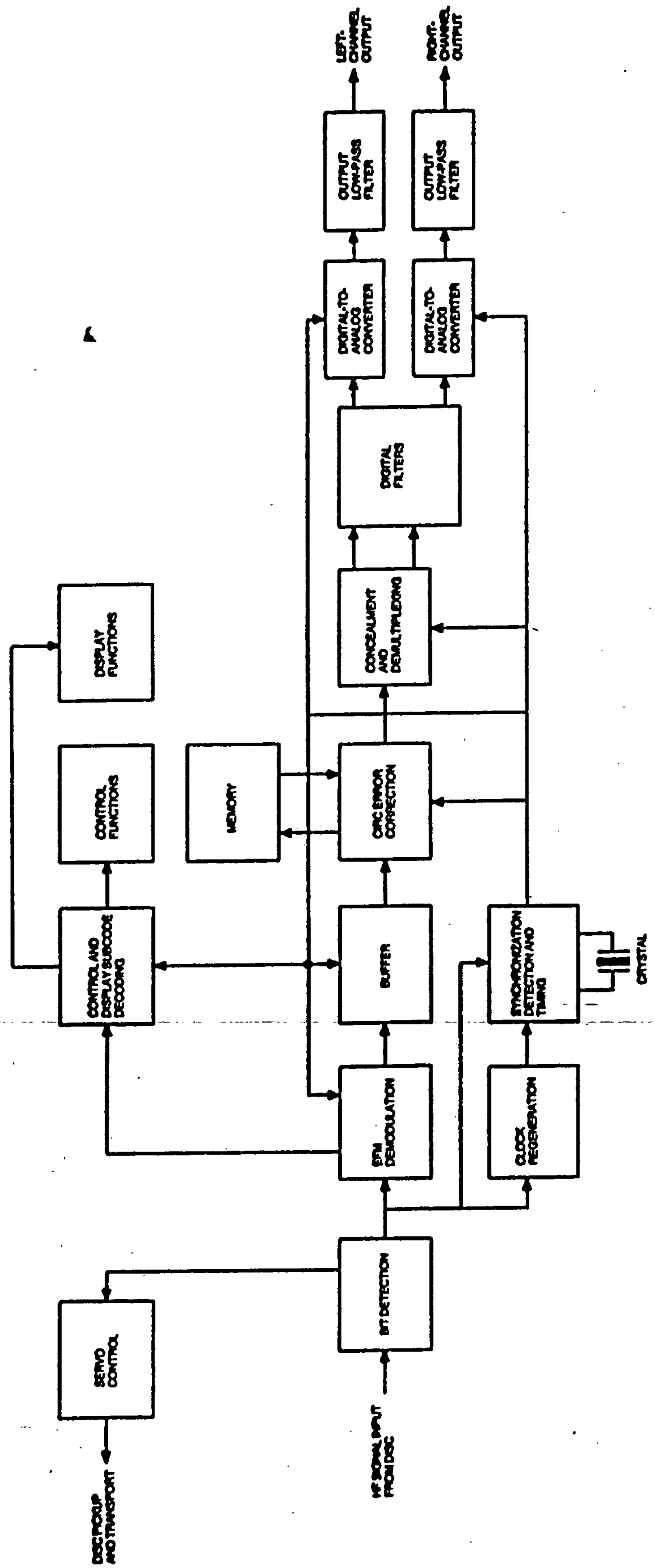


Figure 3.5 *A bump (pit) height causes a 1/2 wavelength path difference relative to land.*

Prior Art Fig. 5



Prior Art
Figure 6

Figure 4.1 *Block diagram of a CD player showing audio path, as well as servo*

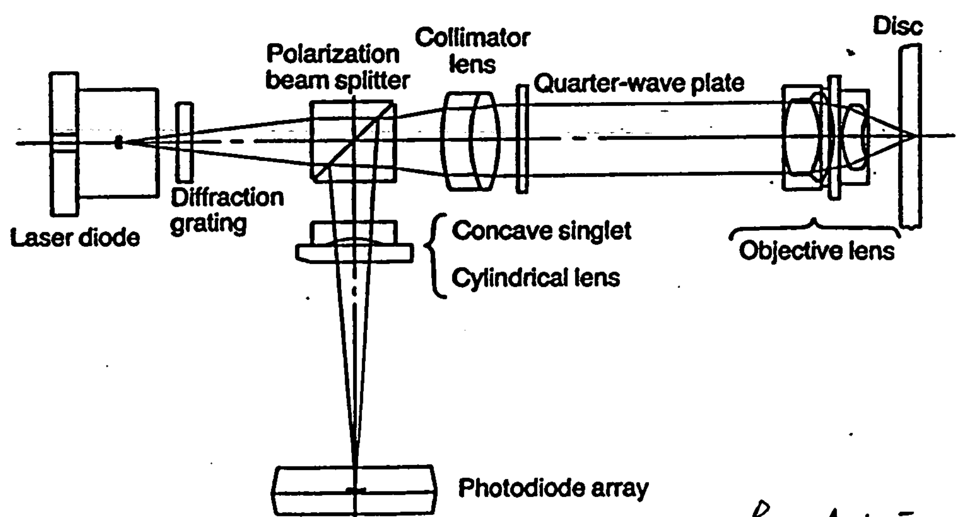
pickups are usually mounted on the end of a pivoting arm which swings the pickup across the disc in an arc. Three-beam pickups are always mounted on a sled which slides linearly across the disc. Let's consider both types of pickups, beginning with the three-beam design.

Three-Beam Optical Design

Although design particulars vary among manufacturers, three-beam pickups are generally similar in function. Figure 4.3 illustrates the optical path of a three-beam pickup. A one-beam pickup uses a similar optical path.

To achieve sharp focus on the data surface and proper intensity modulation from the pit height, it is necessary to use a laser as the light source. Laser is an acronym for *light amplification by stimulated emission of radiation*. A laser uses an optical resonator to stimulate atoms to a higher energy level that induces them to radiate in phase. Laser light differs significantly from white, visible light. A light bulb, for example, radiates all the frequencies of the spectrum at all different phases. A laser light is monochromatic (composed of a single frequency), and is coherent in phase. Phase coherency is vital, of course, to implement phase cancellation in the beam produced by disc pits so that disc data can be read. CD pickups use an aluminum gallium arsenide (AlGaAs) semiconductor laser with, for example, a 0.5 milliwatt optical output radiating a coherent-phase laser beam with a 780 nanometer wavelength (some manufacturers use 790 nanometers). The beam is thus comprised of near-infrared light.

The laser diode is placed at the focal point of a collimator lens with a long focal distance. Its purpose is to make the divergent light rays parallel.



Prior Art Fig. 7

Figure 4.3 *Optical path of a three-beam pickup.*

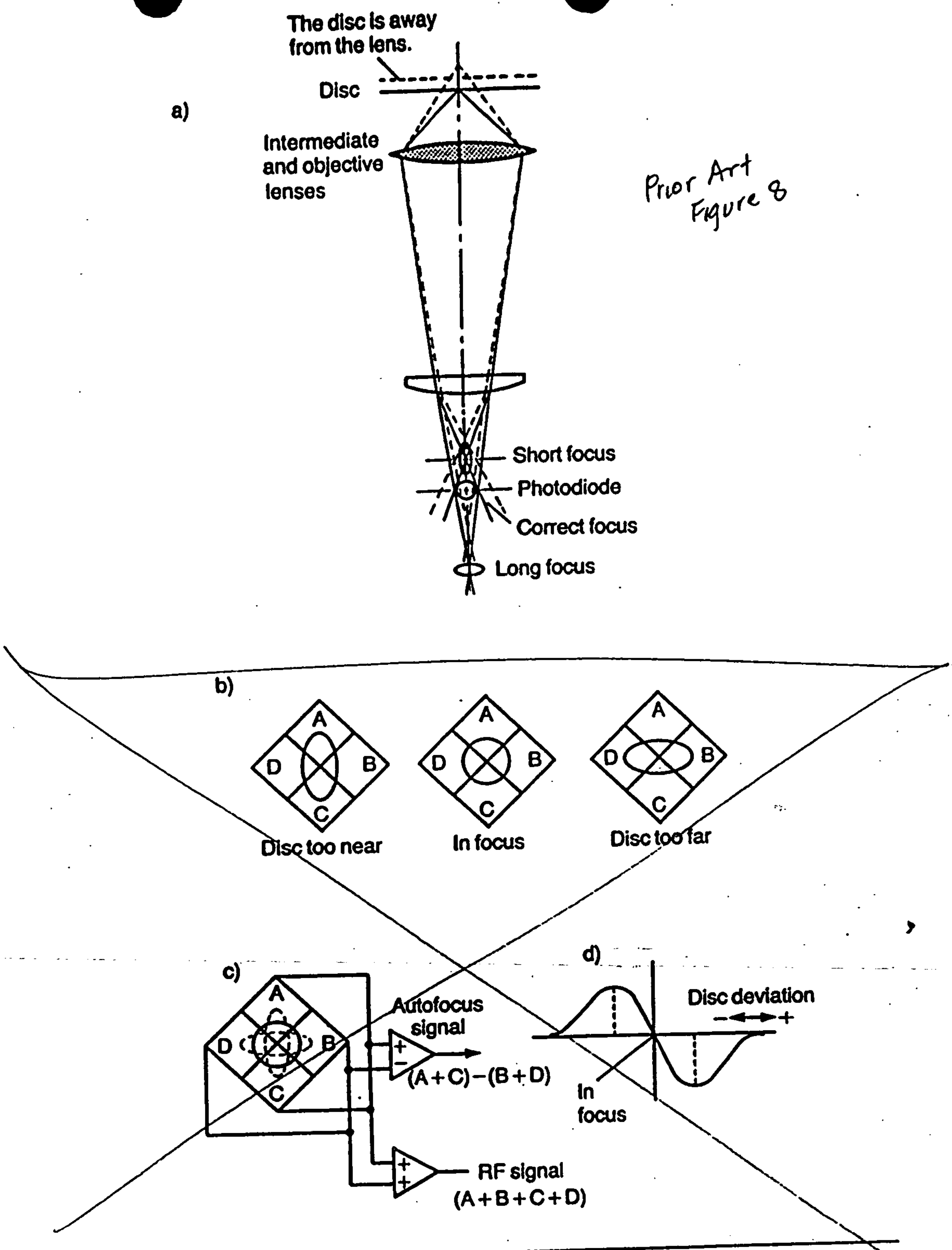


Figure 4.5 *A three-beam pickup uses the properties of astigmatism to generate an auto-focus correction signal.*

Prior Art Figure 9

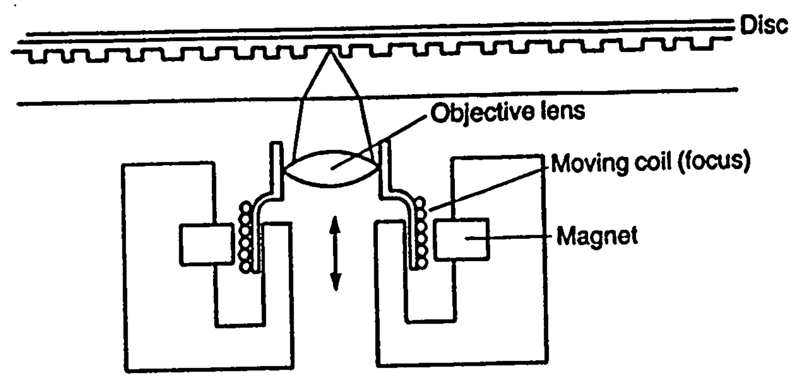


Figure 4.6 *A coil and magnetic structure are used to move the objective lens in the optical path.*

pickup floating underneath the spinning disc, maintaining focus to within a tolerance of approximately ±0.5 micrometers.

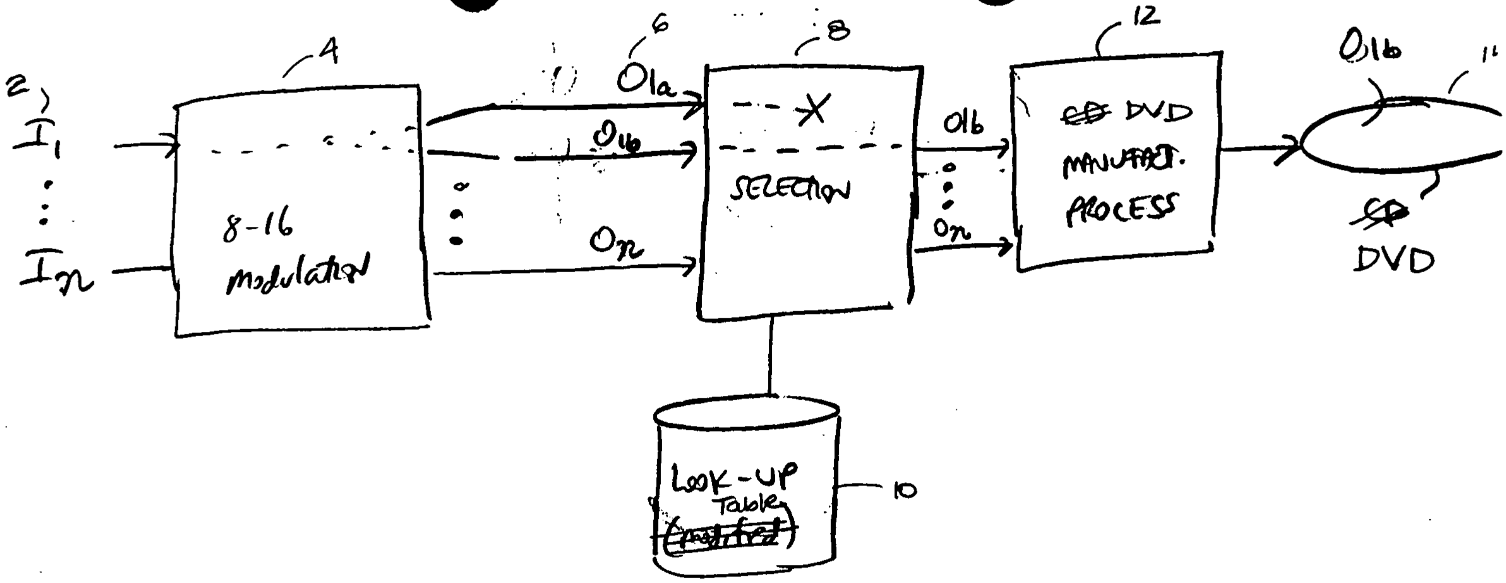
Three-Beam Auto-Tracking

The track pitch, the distance between adjacent laps of the pit spiral, is 1.6 micrometers on a CD, which is too fine a tolerance for any mechanical tracking system to be cost-effective. An auto-tracking system is required. In three-beam pickups, the two secondary beams are used for auto-tracking. The center beam, which carries the information from the disc, is accompanied by the two secondary beams from the point of generation at the diffraction grating. The tracking beams also strike the data surface and are reflected. Their varying intensities are used at two separate photodiodes mounted alongside the four-quadrant photodiode.

The central beam spot covers the pit track while the two tracking beams are aligned above, below, and to either side of the center beam. Their relative position is firmly fixed. When the beam is tracking the disc properly, part of each tracking beam is aligned on the pit edge; the other part covers the mirrored land between pit tracks. The three beams are reflected through the quarter-wave plate and polarizing beam splitter; the main beam strikes the four-quadrant photodiode, and the two tracking beams strike two separate photodiodes (E and F) mounted to either side of the main photodiode, as illustrated in figure 4.7.

As the three spots drift to either side of the pit track, the amount of light reflected from the tracking beams varies. There is less average light intensity reflected by the beam which encounters more pit area, and greater reflected light intensity from the beam which encounters less pit area. The

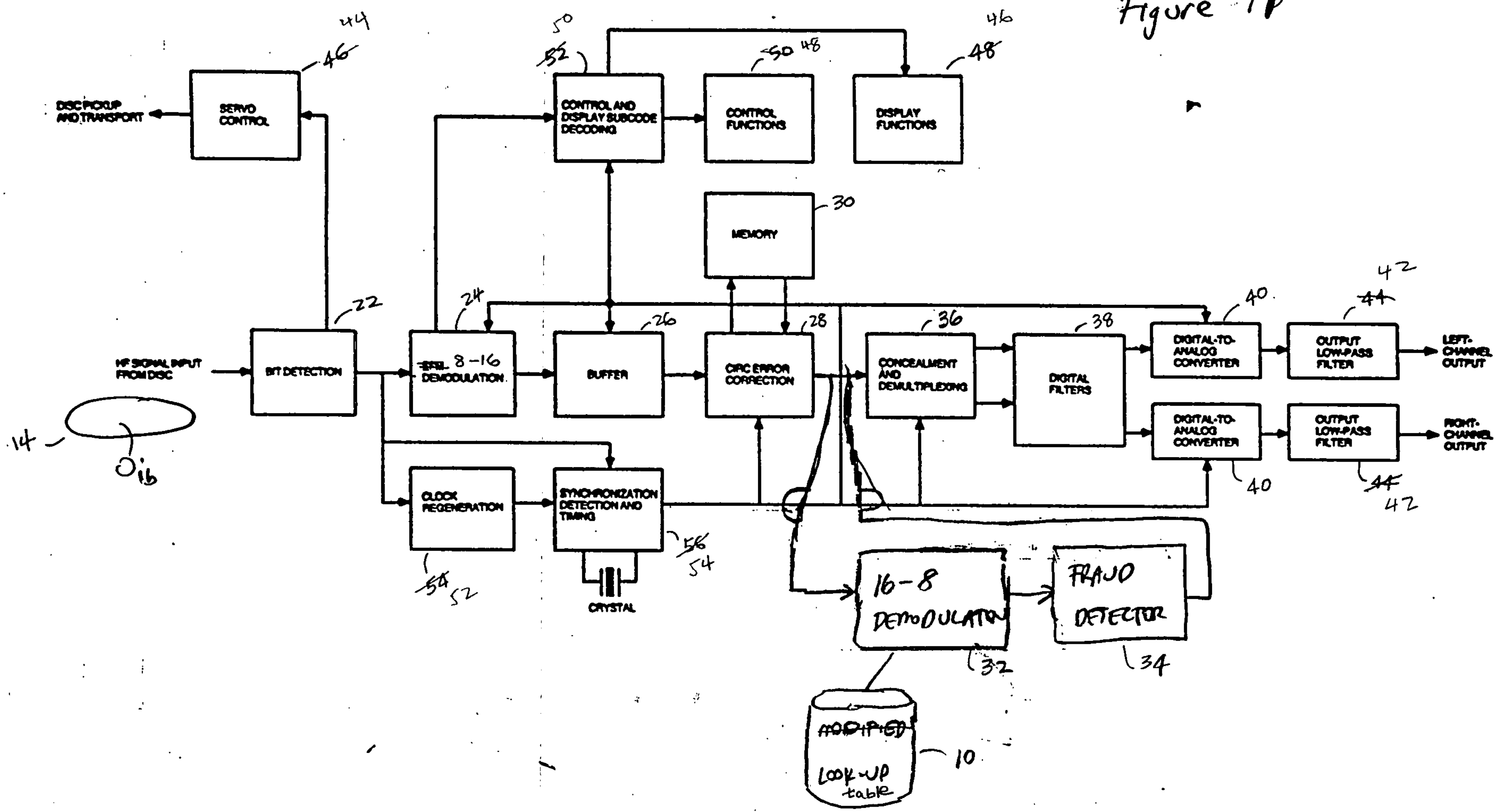
erate



2
I_1
I_n
4
8-16 modulation
6
O_{1a}
O_{1b}
O_n
8
SELECTION
O_{1b}
O_n
12
DVD MANUFACT. PROCESS
O_{1b}
11
DVD
Look-up Table
10

Fig. 10

Figure 1b



DISC PICKUP AND TRANSPORT
SERVO CONTROL
44
46
CONTROL AND DISPLAY SUBCODE DECODING
50
52
CONTROL FUNCTIONS
50
48
DISPLAY FUNCTIONS
46
48
MEMORY
30
HF SIGNAL INPUT FROM DISC
14
16
BIT DETECTION
22
EFM 8-16 DEMODULATION
24
BUFFER
26
CIRC ERROR CORRECTION
28
CONCEALMENT AND DEMULTIPLEXING
36
DIGITAL FILTERS
38
DIGITAL-TO-ANALOG CONVERTER
40
OUTPUT LOW-PASS FILTER
42
44
LEFT-CHANNEL OUTPUT
RIGHT-CHANNEL OUTPUT
CLOCK REGENERATION
54
52
SYNCHRONIZATION DETECTION AND TIMING
56
54
CRYSTAL
16-8 DEMODULATOR
32
FRAUD DETECTOR
34
MODIFIED LOOK-UP table
10

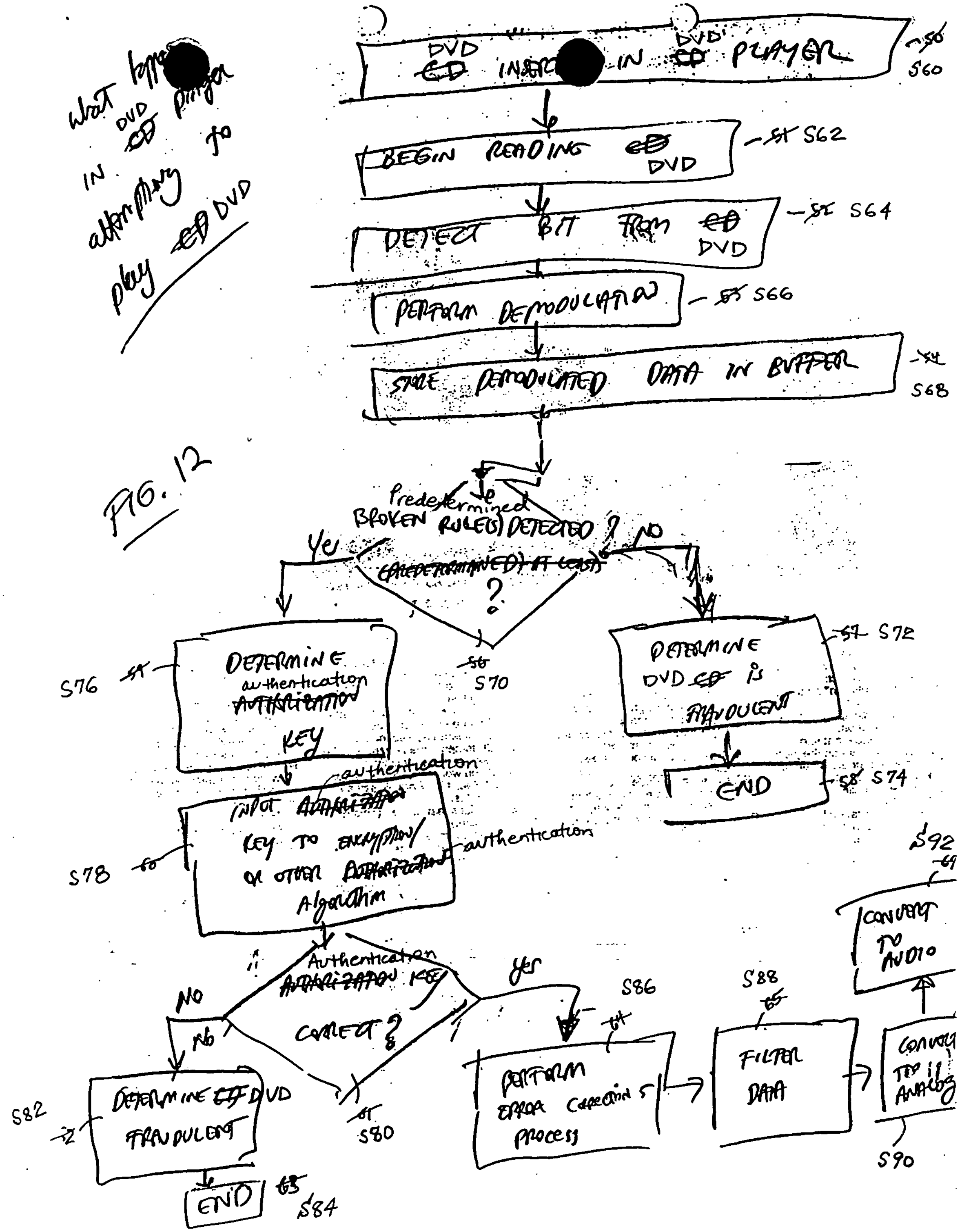

what happ... in DVD player to attempting to play DVD
DVD INSE... IN DVD PLAYER
S60
BEGIN READING DVD
S62
DETECT BIT FROM DVD
S64
PERFORM DEMODULATION
S66
STORE DEMODULATED DATA IN BUFFER
S68
Predetermined BROKEN RULE(S) DETECTED ?
Yes
NO
S70
DETERMINE authentication KEY
S76
DETERMINE DVD is FRAUDULENT
S72
END
S74
INPUT authentication KEY TO ENCRYPTION/ OR OTHER authentication Algorithm
S78
Authentication KEY CORRECT ?
S80
NO
Yes
DETERMINE DVD FRAUDULENT
S82
END
S84
PERFORM ERROR CORRECTION PROCESS
S86
FILTER DATA
S88
CONVERT TO ANALOG
S90
CONVERT TO AUDIO
S92

FIG. 12

What ... DVD was one so that is wrong DVD attempts to second record data

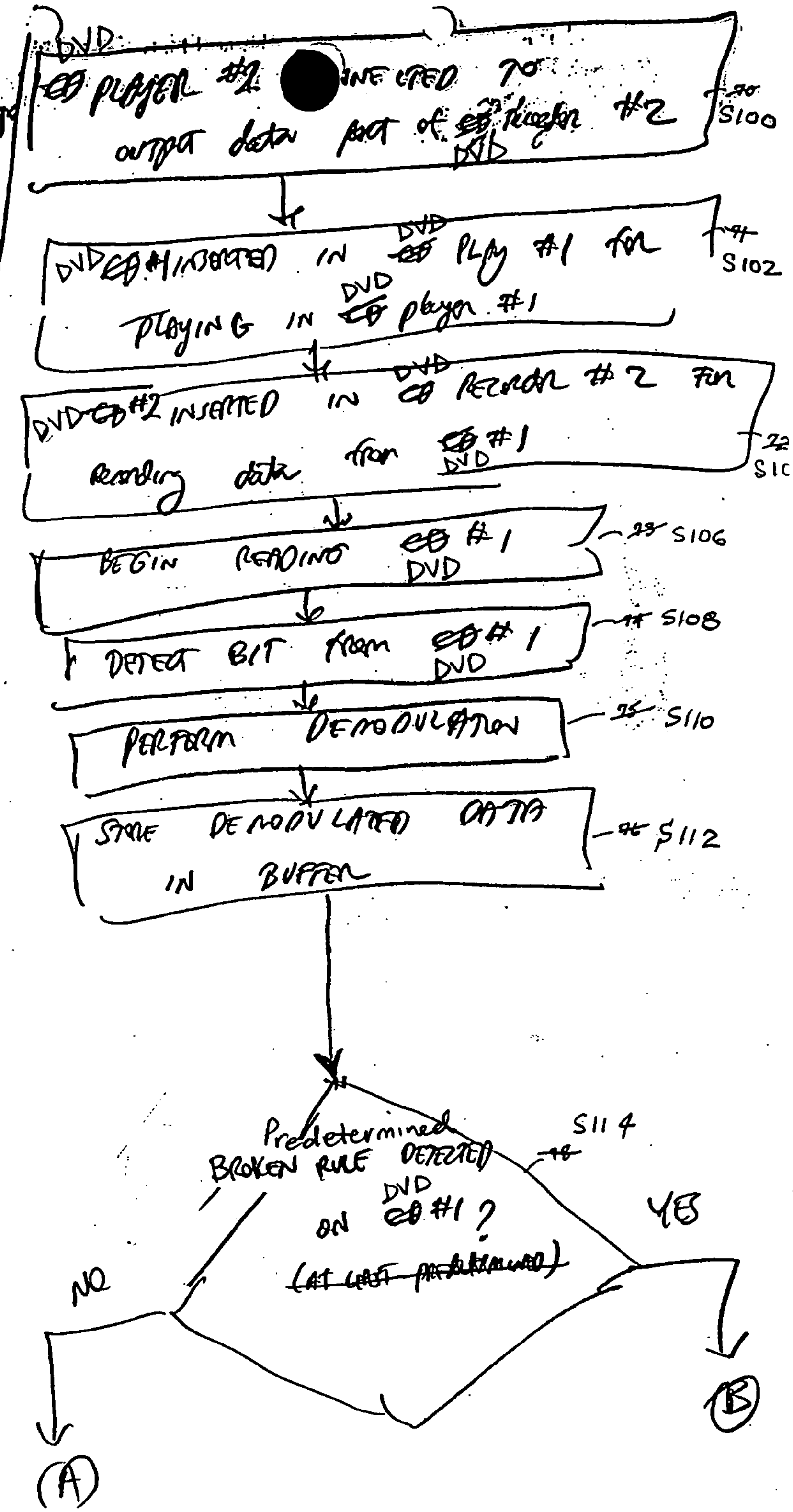


FIG. 13

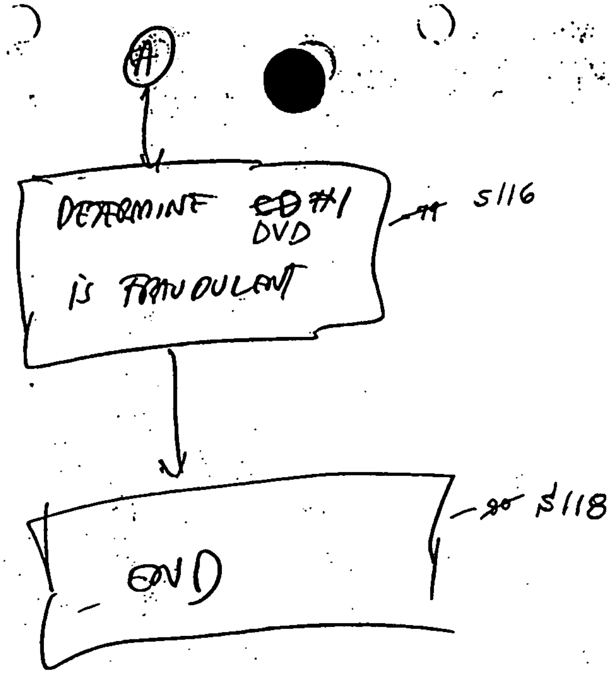


FIG. 14

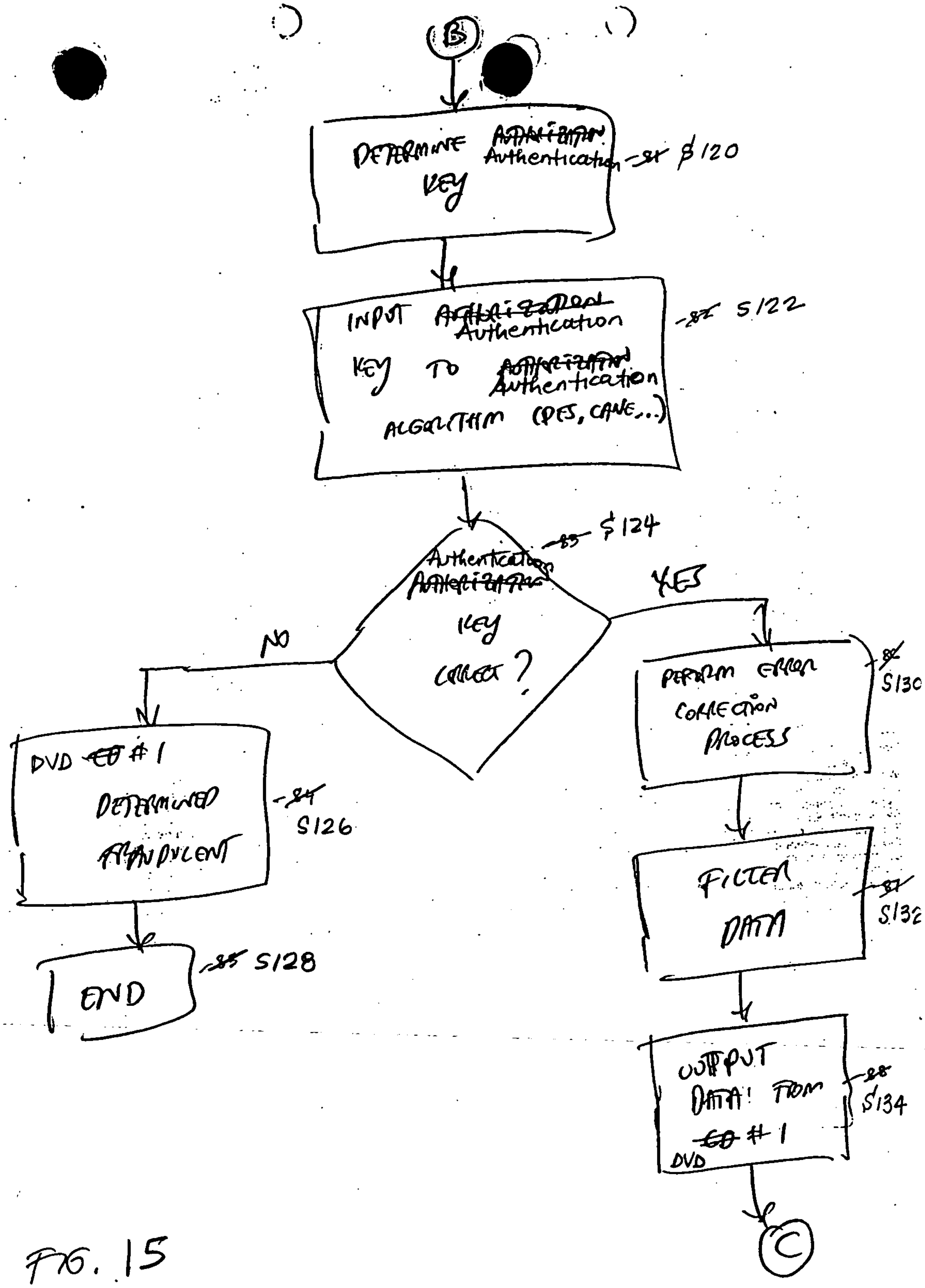

B
DETERMINE ~~AUTHORIZATION~~ Authentication KEY
~~84~~ S120
INPUT ~~AUTHORIZATION~~ Authentication KEY TO ~~AUTHORIZATION~~ Authentication ALGORITHM (DES, CANE,..)
~~82~~ S122
Authentication ~~AUTHORIZATION~~ KEY CORRECT ?
~~83~~ S124
NO
YES
DVD ~~CD~~ #1 DETERMINED FRAUDULENT
~~84~~ S126
END
~~85~~ S128
PERFORM ERROR CORRECTION PROCESS
~~86~~ S130
FILTER DATA
~~87~~ S132
OUTPUT DATA FROM ~~CD~~ DVD #1
~~88~~ S134
C

FIG. 15

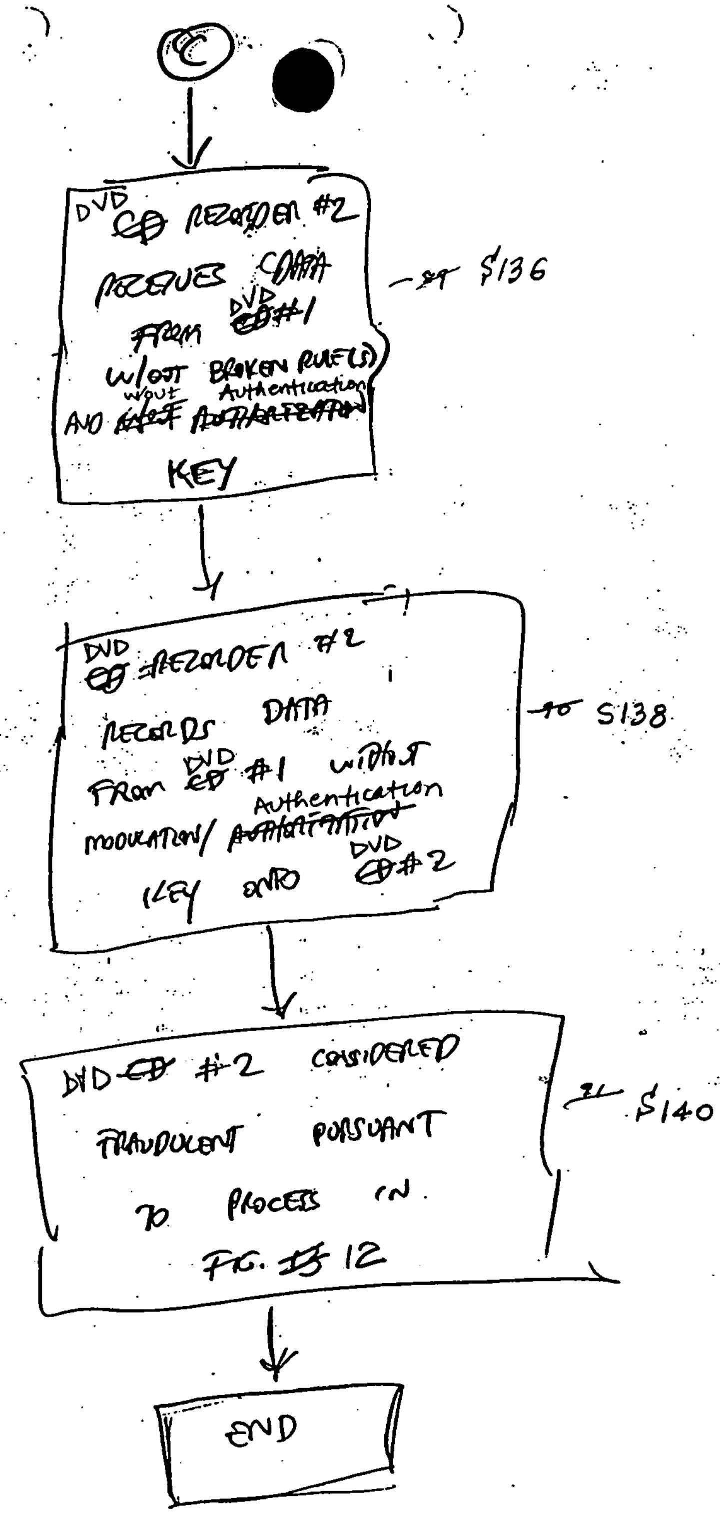

C
DVD ~~CD~~ RECORDER #2 RECEIVES DATA FROM DVD ~~CD~~ #1 W/OUT BROKEN RULE(S) AND w/out ~~AUTHENTICATION~~ Authentication KEY
S136
DVD ~~CD~~ RECORDER #2 RECORDS DATA FROM DVD ~~CD~~ #1 WITHOUT MODULATION/ Authentication ~~AUTHENTICATION~~ KEY ONTO DVD ~~CD~~ #2
S138
DVD ~~CD~~ #2 CONSIDERED FRAUDULENT PURSUANT TO PROCESS IN FIG. ~~13~~ 12
S140
END

FIG. 16

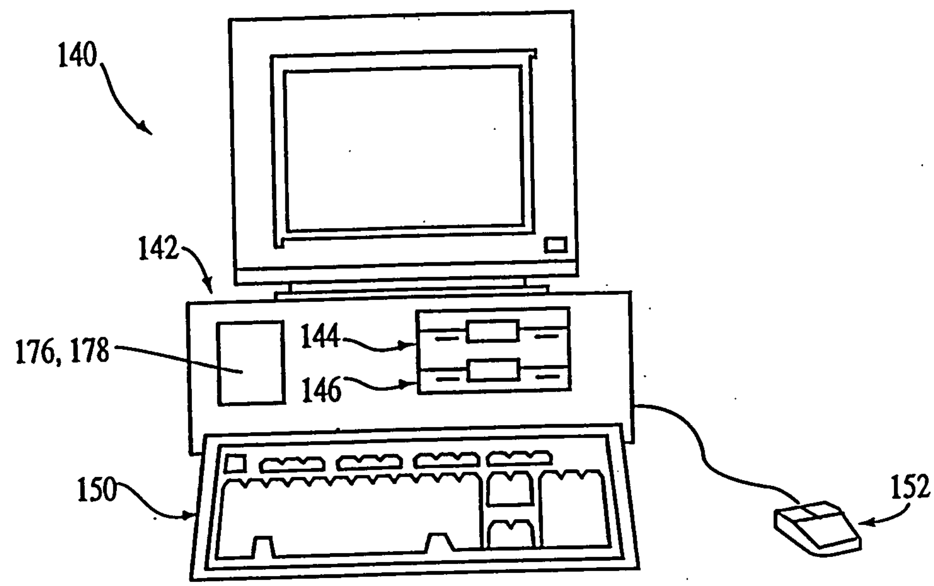

140
142
176, 178
144
146
150
152

FIG. 17

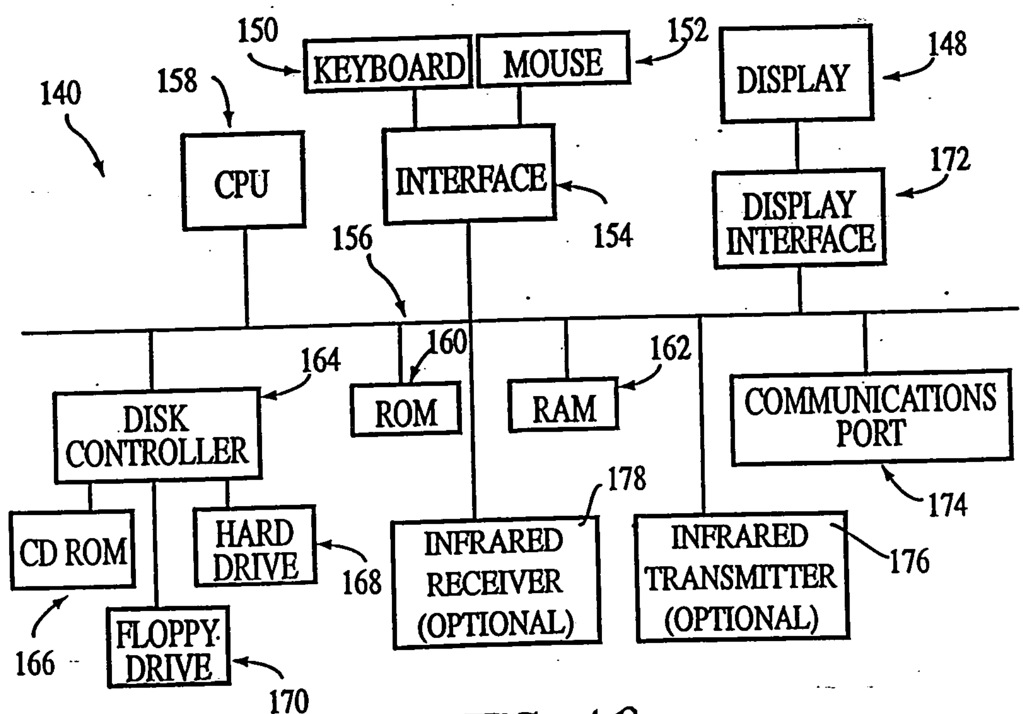
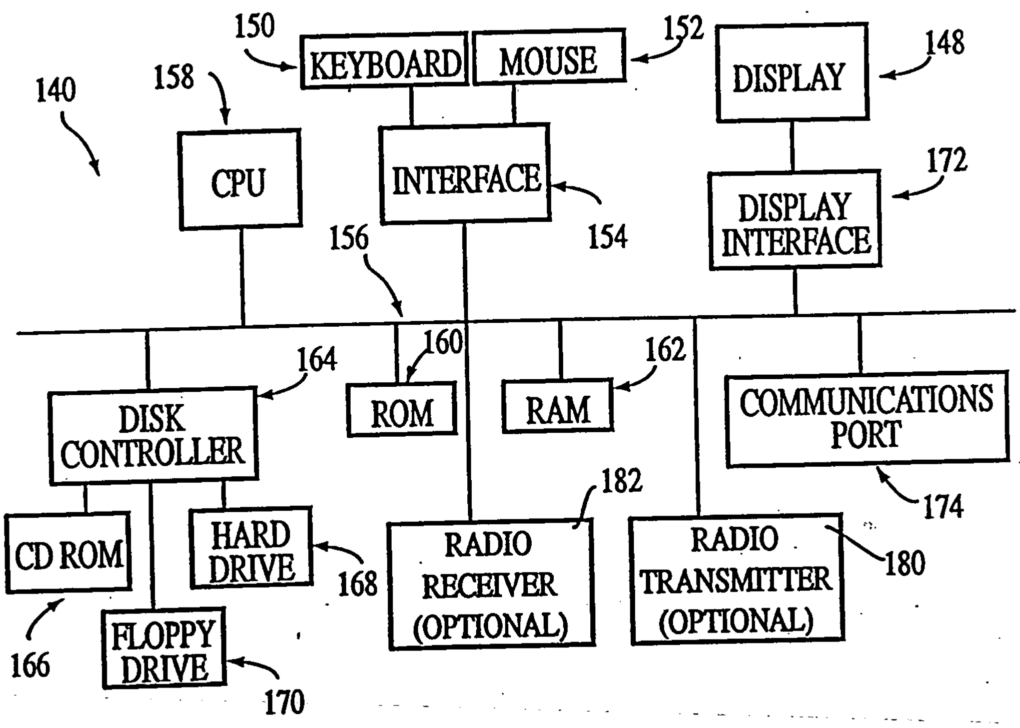

140
150
KEYBOARD
MOUSE
152
DISPLAY
148
158
CPU
INTERFACE
154
172
DISPLAY INTERFACE
156
160
164
DISK CONTROLLER
ROM
RAM
162
COMMUNICATIONS PORT
174
178
CD ROM
HARD DRIVE
168
INFRARED RECEIVER (OPTIONAL)
INFRARED TRANSMITTER (OPTIONAL)
176
166
FLOPPY DRIVE
170

FIG. 18



140
150
KEYBOARD
MOUSE
152
DISPLAY
148
158
CPU
INTERFACE
154
172
DISPLAY INTERFACE
156
160
ROM
RAM
162
164
DISK CONTROLLER
COMMUNICATIONS PORT
174
CD ROM
166
HARD DRIVE
168
FLOPPY DRIVE
170
182
RADIO RECEIVER (OPTIONAL)
RADIO TRANSMITTER (OPTIONAL)
180

FIG. 19

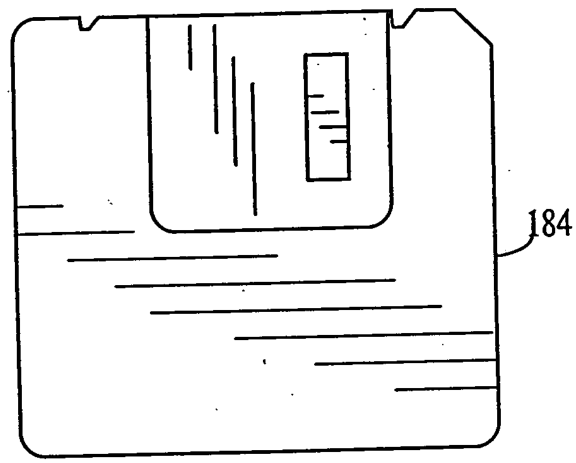


FIG. 20

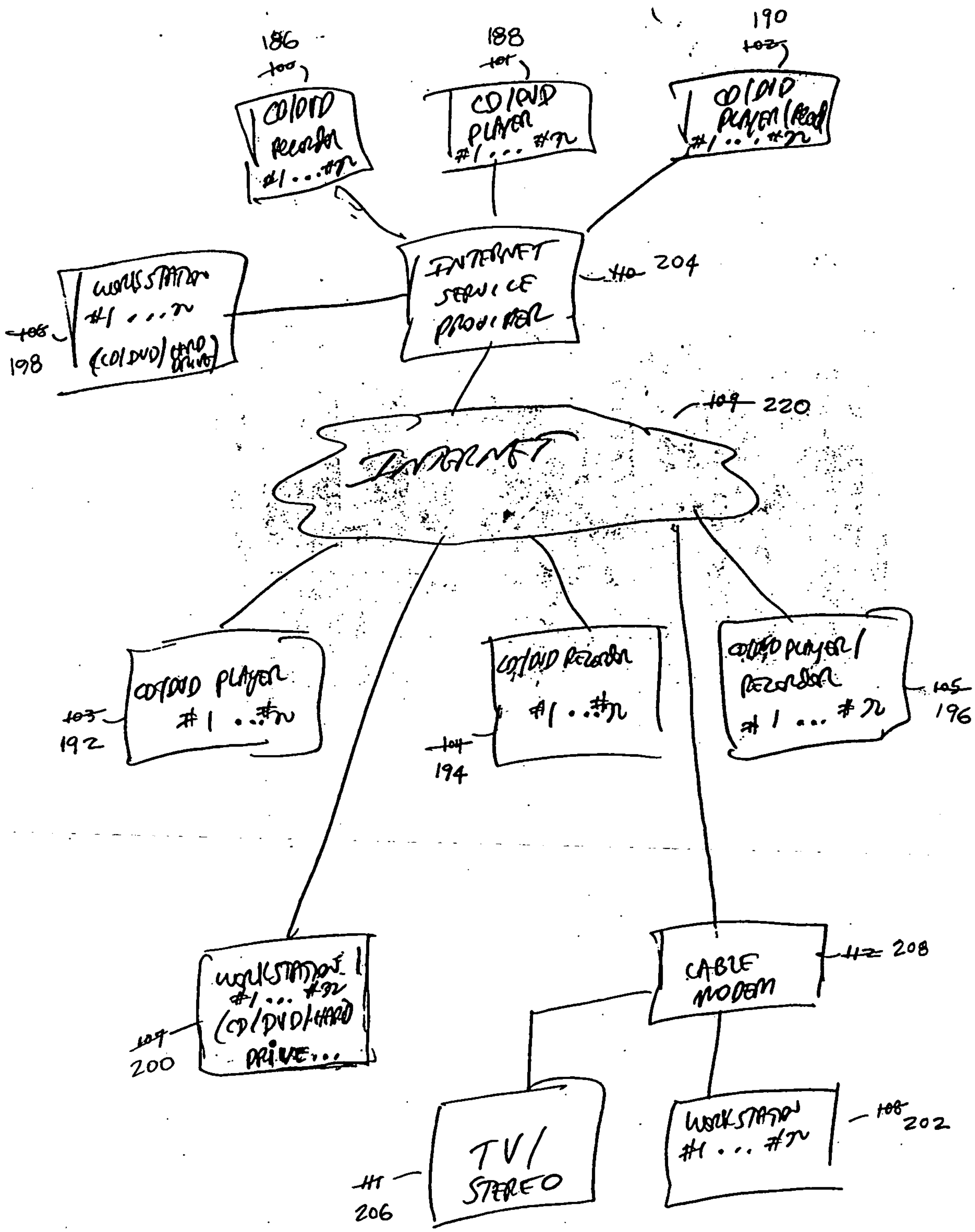

186
100
CD/DVD RECORDER #1 ... #n
188
101
CD/DVD PLAYER #1 ... #n
190
102
CD/DVD PLAYER/RECORDER #1 ... #n
WORKSTATION #1 ... n (CD/DVD/HARD DRIVE)
108
198
INTERNET SERVICE PROVIDER
110 204
109 220
INTERNET
CD/DVD PLAYER #1 ... #n
103
192
CD/DVD RECORDER #1 ... #n
104
194
CD/DVD PLAYER/RECORDER #1 ... #n
105
196
WORKSTATION #1 ... #n (CD/DVD/HARD DRIVE...
107
200
CABLE MODEM
112 208
TV/STEREO
111
206
WORKSTATION #1 ... #n
108 202

Figure 21

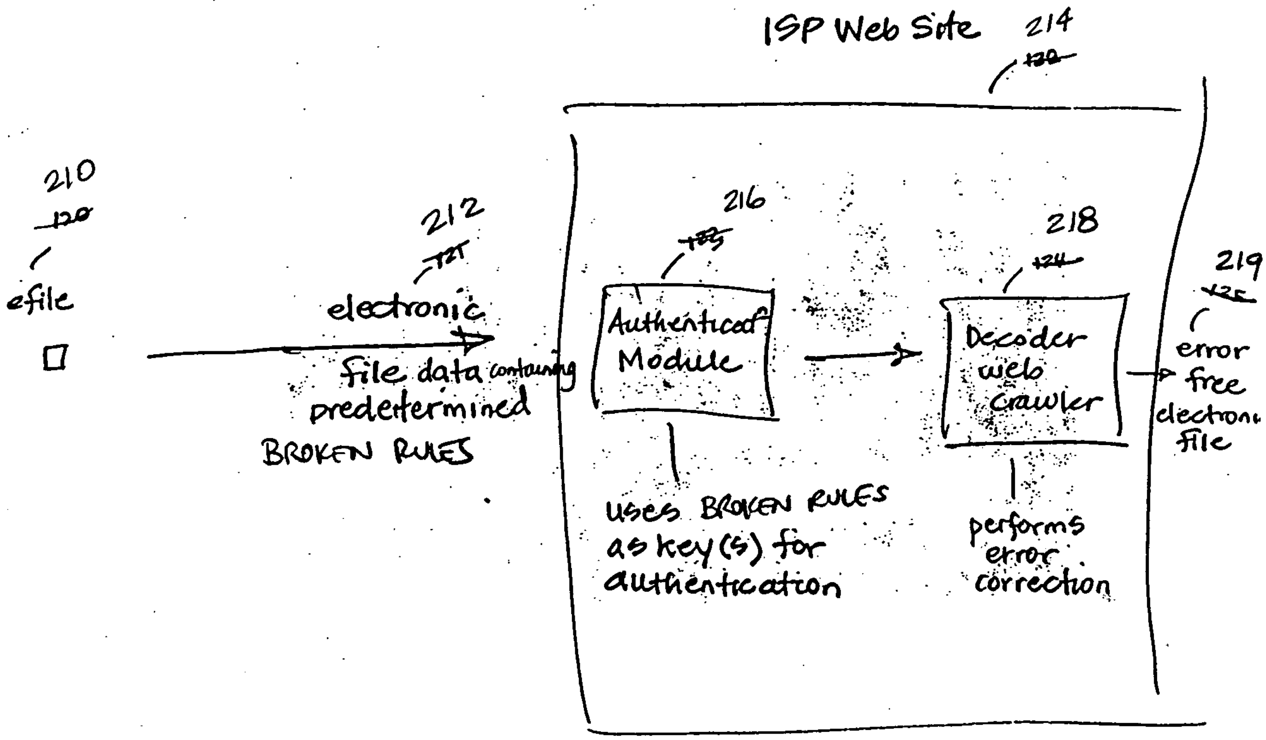
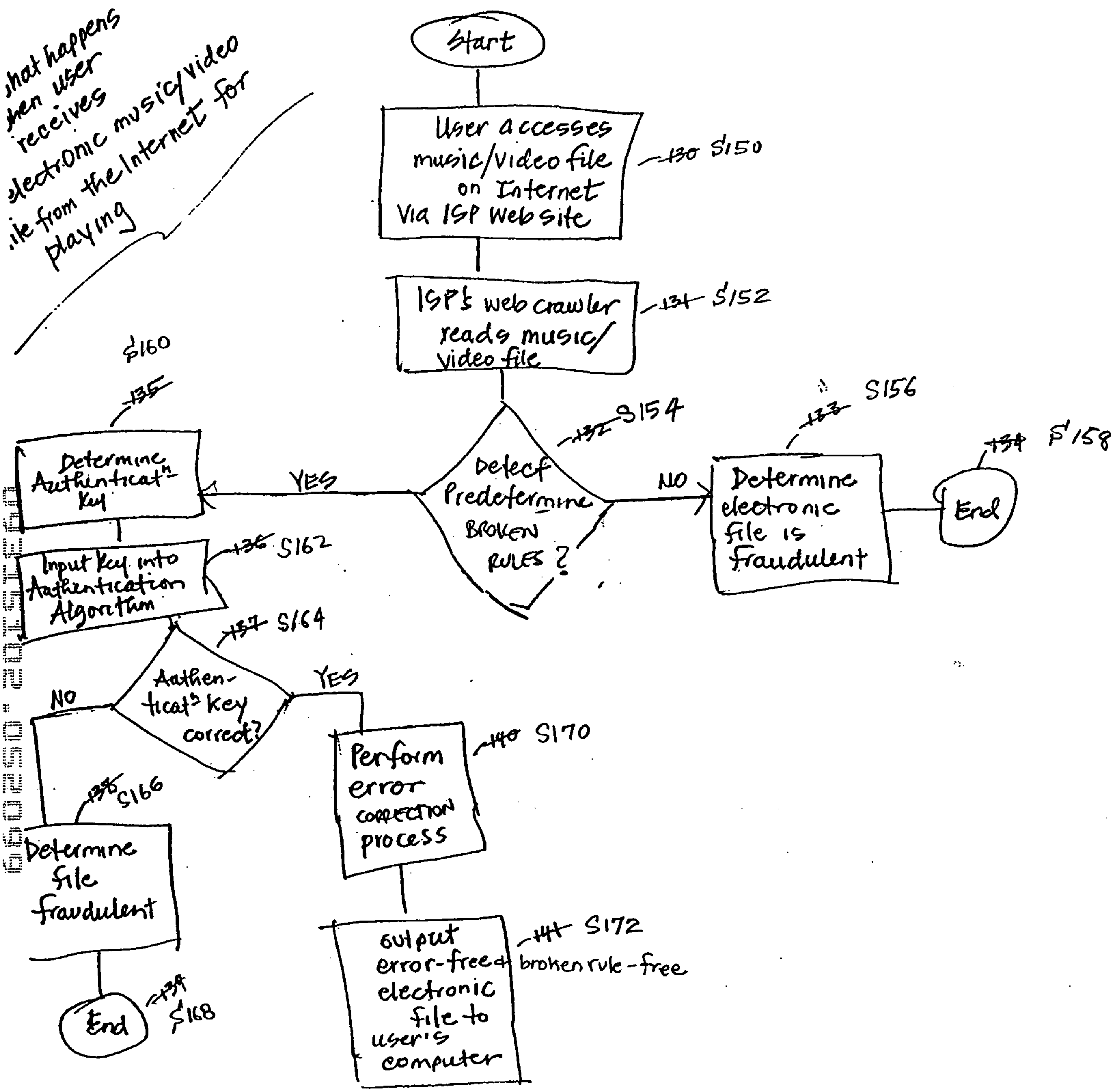

ISP Web Site
214
210
efile
212
electronic
file data containing
predetermined
BROKEN RULES
216
Authenticat
Module
uses BROKEN RULES
as key(s) for
authentication
218
Decoder
web
crawler
performs
error
correction
219
error
free
electronic
file

FIGURE 22



what happens when user receives electronic music/video file from the Internet for playing
Start
User accesses music/video file on Internet Via ISP Web site
~~130~~ S150
ISP's web crawler reads music/video file
~~131~~ S152
Detect Predetermine BROKEN RULES ?
~~132~~ S154
NO
Determine electronic file is fraudulent
~~133~~ S156
End
~~134~~ S158
YES
Determine Authenticatn Key
~~135~~ S160
Input Key into Authentication Algorithm
~~136~~ S162
Authenticatn Key correct?
~~137~~ S164
NO
Determine file fraudulent
~~138~~ S166
End
~~139~~ S168
YES
Perform error CORRECTION process
~~140~~ S170
output error-free + broken rule-free electronic file to user's computer
~~141~~ S172

FIGURE 23

what happens when user receives electronic music/video file from Internet for recording

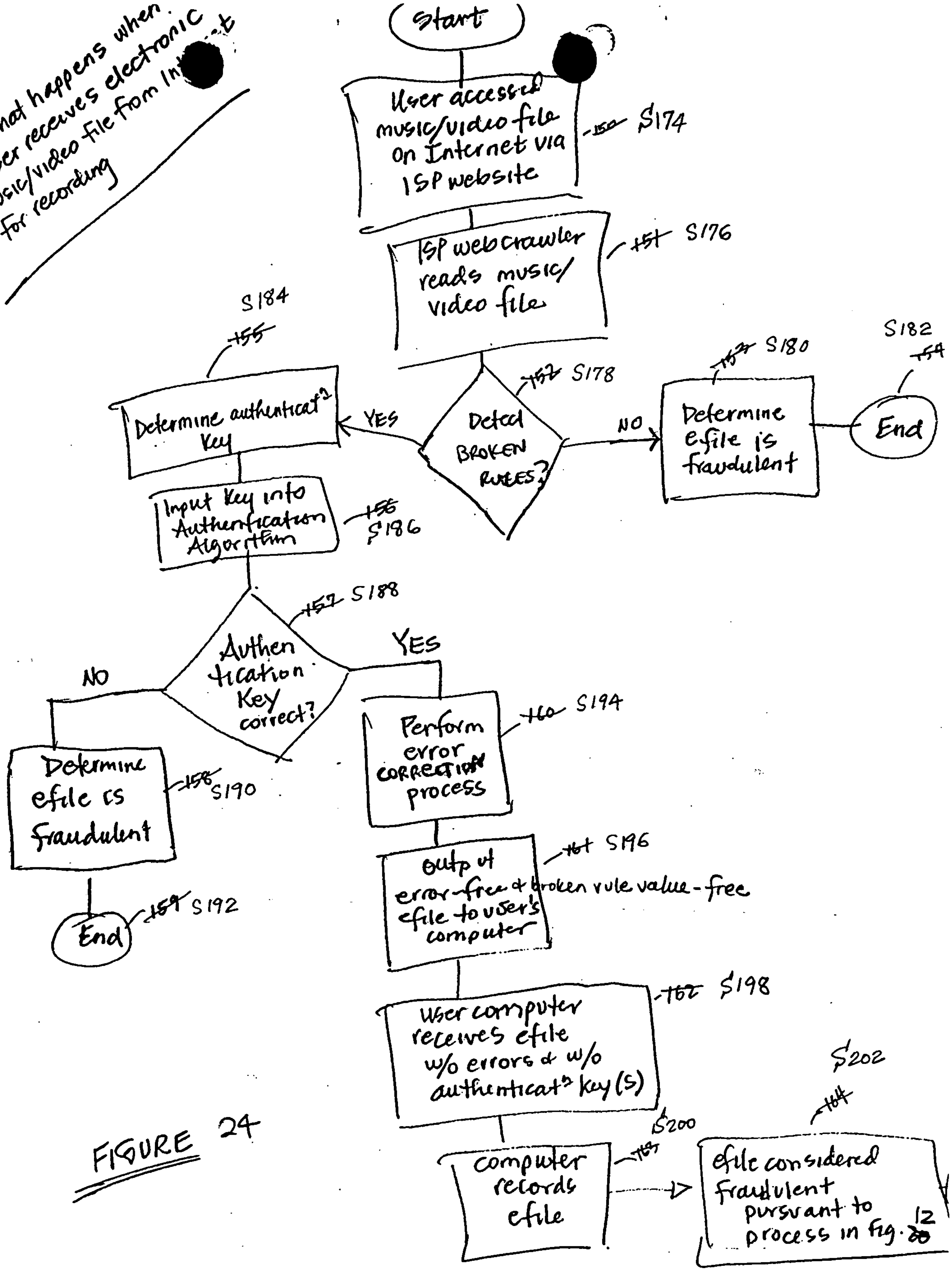


FIGURE 24

660250 " 20TSTE60

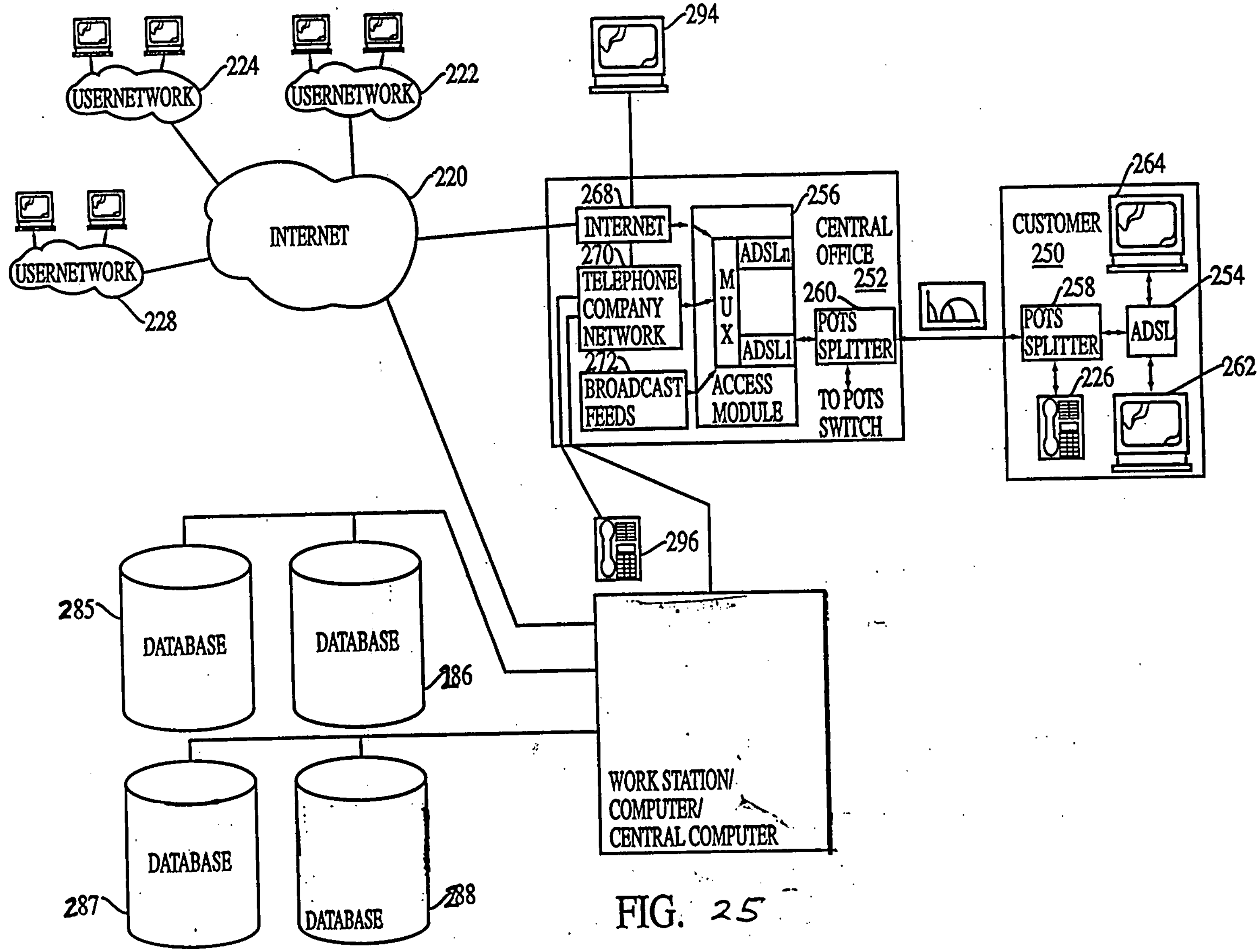


FIG. 25

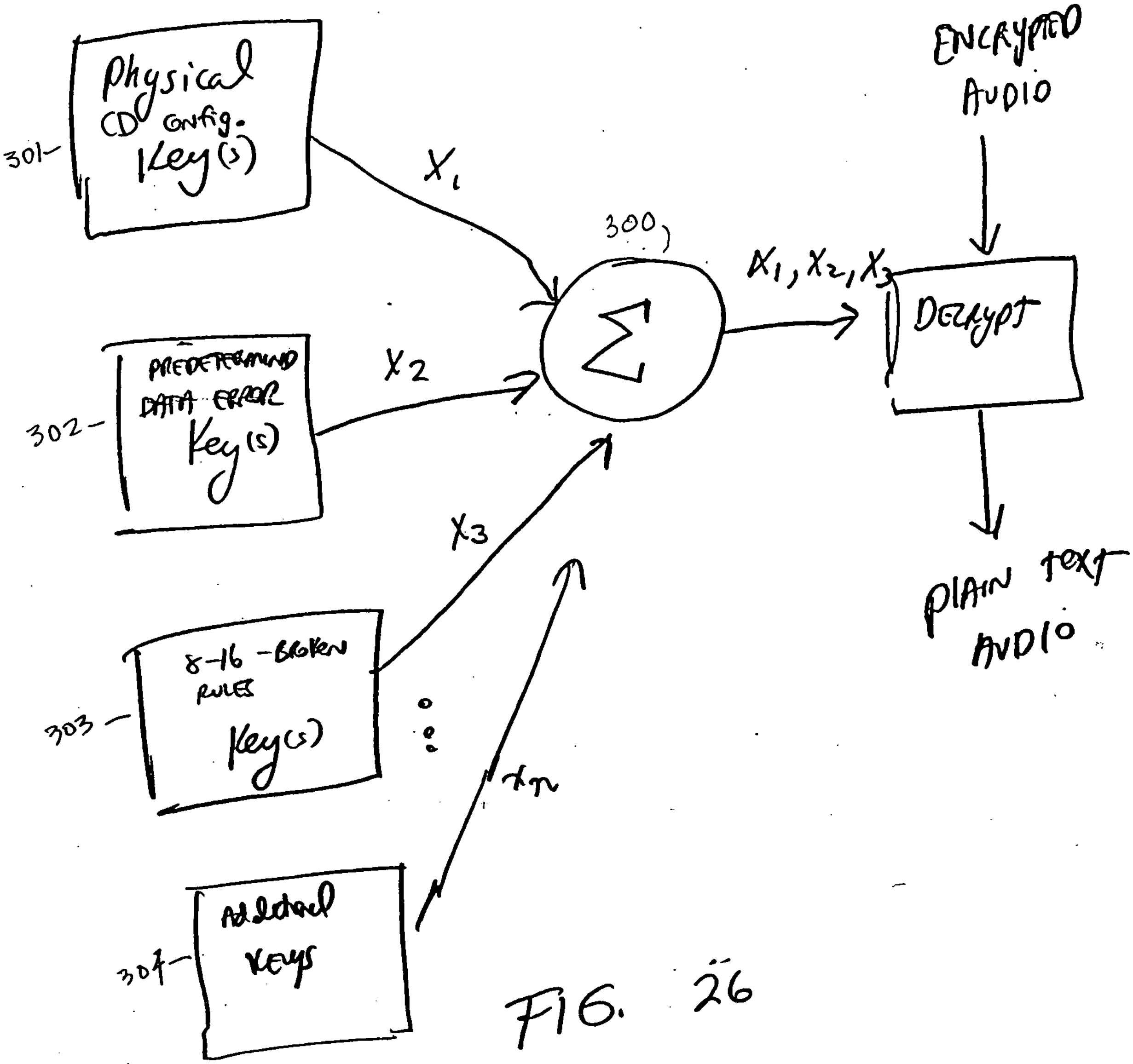

Physical CD config. Key(s)
301
PREDETERMINED DATA ERROR Key(s)
302
8-16 - BROKEN RULES Key(s)
303
Additional Keys
304
X1
X2
X3
Xn
300
X1, X2, X3
ENCRYPTED AUDIO
DECRYPT
PLAIN TEXT AUDIO

FIG. 26